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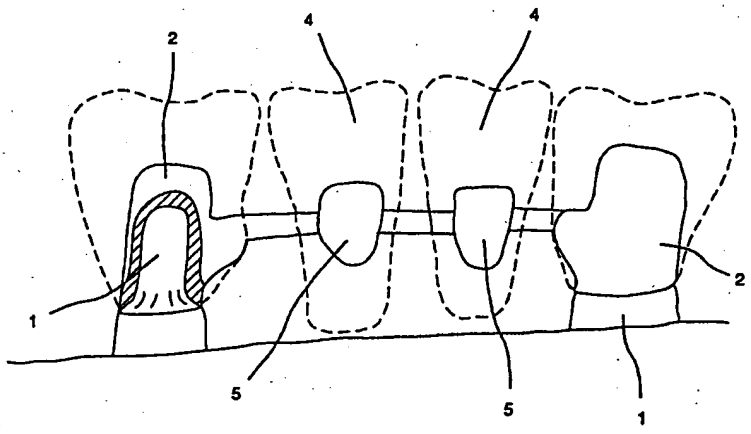

(57) Abstract

The present invention concerns a system for dental restorations, in particular, a system for achieving dental restoration components such as bridges, for example. The system includes a restoration component including a cap (2) for firmly attaching to a ground–down tooth (1) or other foundation and a beam (3) extending out from this cap, whereby the cap and the beam are executed in ceramic material and the cap (2) has a cut–out cavity (6) plus that the beam has an end piece (7) shaped to complement the cut–out cavity to allow their mutual joining. In addition, a blank for producing a beam according to the above is also included, whereby the blank is roughly pre–formed with a specified geometry intended for individual finishing. The procedure associated with the system includes that geometric information about the prepared restoration site is read into a computer, that the replacement teeth or replacement body is designed in a computer program, that cap and beam blanks are chosen from a specified number of known roughly pre–formed blanks, that a numerically–controlled machine tool executes the final machining of the cap and the beam, and that the parts are assembled to form the restoration component.

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System for dental components

The present invention concerns a system for dental restorations. in particular, a system for achieving dental restoration components such as bridges, for example.

When constructing dental components such as bridges, a frame is usually cast in metal after one has made a model of the frame in wax by means of taking an impression of the damaged and prepared area of the patient. The frame includes two caps for the accommodation of and attachment at a prepared tooth as well as a beam to hold the caps together. The frame can be tested on the patient and adjusted so that it fits before the frame is coated, e.g. with ceramics or plastic. to re-create a tooth or a group of teeth. This bridge is attached firmly at two ground-down teeth flanking the damaged area. between which teeth the bridge extends. The attachment is carried out by the cap being firmly cemented over the ground-down tooth. If the caps and the beam that joins them together are produced separately, or if the span needs to be adjusted, the separate parts are soldered together edge to edge.

Numerically-controlled machine tools are used when producing dental bodies such as inserts, caps and crowns today. These usually employ what is known as CAM technology. A crown of the desired shape is built-up in a software program, and with knowledge of the geometry of a worked piece or a blank, the computer can work out a pattern of movements for a known machine tool, usually a milling or grinding tool, that by cutting away at the blank, produces the desired restoration body.

Several ceramic materials have been found to display the characteristics that are advantageous for this application. One ceramic that can be used with advantage is zirconium, ZrO_2. Blanks of zirconium ceramic can be produced in several shades of colour that resemble those of teeth and, like several other candidate ceramics. it is a hard material that is very resistant to being worn down. It is therefore possible to produce a solid crown in one piece of this tooth-coloured material. Zirconium and similar ceramic materials are, however. not possible to weld or join together in a similar way, which is why ceramic crowns or caps have not been considered for dental components such as bridges and similar. The same also applies for plastics with ceramic-like characteristics.

With technology known today, it has so far not been possible to produce ceramic bridges in one piece with reasonable strength and precision in a reasonable time and at an acceptable cost. The reasons for this include, amongst others. that it means far too great a volume has to be cut away when machining the shape from a ceramic block. and that problems

arise during the rotation of the relatively large body of the bridge blank that is carried out in the machine tool so that the machine tool is able to access the blank from all positions.

It is nevertheless desirable to produce as much as possible and preferably the whole of the finished bridge in one and the same material. Ceramics such as zirconium are desirable materials to use from a biological point of view, but as a consequence of their material characteristics, are difficult and expensive to machine. Furthermore, joining together ceramic components is a problem when one takes into account both precision and durability.

We now suggest a system that overcomes the present difficulties of constructing integrated ceramic dental restoration bodies, i.e. restoration components.

The features of the invention are defined in the characteristics of the enclosed independent claims.

The features of embodiments of the invention are evident from the claims below as well as from the following detailed description of one preferred embodiment of the invention. The following description includes references to the enclosed illustrations, where **fig. 1** shows schematically a side view of a bridging component according to one embodiment of the present invention, **fig. 2** shows schematically a perspective view showing separated parts of the bridging component's connection according to fig. 1, **fig. 3** shows a view of the cap according to fig. 1 from underneath, and **fig. 4** shows a partially exposed view of an alternative embodiment of the invention.

Fig. 1 shows schematically a damaged tooth provided with a bridge component according to one embodiment of the invention. Two teeth are missing from the example shown and the adjacent teeth 1 are ground-down so that they can be used as a foundation for the bridge construction according to known techniques.

The bridging construction includes two caps 2 each arranged to accommodate a ground-down tooth 1 and via a suitable means to be firmly joined to this. This join can be made using cement, glue or other suitable adhesive material.

A beam 3 intended to support the re-created teeth 4 extends between the caps. The replacement teeth can be arranged as one piece with the beam or, as in the present example, be built-up on the beam. In the present embodiment, the beam is provided with what are known as cores 5 at specified positions. The replacement teeth 4 are built-up by the core being coated with layers of plastic material or ceramic to achieve the desired shape. A similar coating on the caps 2 can in the same way build up the desired shape of the tooth at the ground-down permanent teeth.

In the present embodiment, the caps 2 and beam 3 are made in the same ceramic material, zirconium.

With reference to fig. 2, cap 2 is provided with a recess 6 that when observed in the longitudinal direction of the beam, displays an opening with cut-out edges for accommodating the end piece of the beam. In addition, the end piece of the beam 7 has a complementary shape that fits exactly in the cavity 6, whereby a relatively stable and durable attachment between the beam and the cap is achieved.

The cap according to fig. 1 and 2 has an internal cavity 8 that is shown schematically in fig. 3 and that is adjusted to and intended for accommodating a prepared ground-down tooth 1. This cavity has an essentially vertical longitudinal axis that is parallel with the longitudinal axis of the ground-down tooth.

In the present embodiment, cavity 6 for accommodating the end piece of the beam is executed as a vertical groove in the cap, where the groove has an opening 6a in a horizontal direction towards the damaged area and where the opening 6a has cut-out sides. In this way, the end piece of the beam 7, which is shaped to complement the profile of the groove, is inserted vertically into the groove through the opening inlet 6b of the groove. When the end piece of the beam 7 is inserted in position, the beam 3 is locked in the direction of insertion when it reaches the bottom of the groove 6. The beam is further stabilised in the horizontal direction of oscillation around the cap by it resting against the edges 6c of the opening. The turning of the beam around its own axis is limited by the extension of the end piece in the longitudinal direction of the groove.

The cut-out groove 6 can have a profile that is T-shaped, dove-tailed, circular or some other cut-out shape. Even though a circular shape has shown itself to be sufficiently stable in the present embodiment, a non-circular cross-sectional shape has a greater area in the joint to accommodate the forces from the beam that are active in a perpendicular plane to the longitudinal direction of the groove, the direction of oscillation.

The end piece of the beam 7 is fixed in the recess or groove, preferably by gluing, cement or similar, or by the connection being coated with ceramic that is then baked.

In this manner, it is not only the glue or cement that has an active role when transferring forces between the parts. The forces are essentially transferred by the parts themselves, which lie direct contact with one another so that they connect with one another and transfer the forces. Their mutual positions relative to one another are fixed and are regulated by

the shapes of the surfaces that join the parts together. Thus, the parts can only be assembled in one way.

When the bridging component according to the present embodiment of the invention is to be produced, the area that is to be restored is first prepared. The geometry of the area is described in a manner suitable for a computer, which is also given information about how the restoration body is to look. The computer compares the geometrical dimensions of the components with information known about available blanks of known dimensions. The blanks can be pre-formed to a larger or lesser extent for individual completion by machining to caps, crowns, beams or other component parts included in the construction. The computer then passes instructions to a numerically-controlled machine tool that completes the machining of the chosen blank to the finished component in question. The bridge is assembled, fixed in place, re-assembled if so required with ceramic or plastic, and thereafter arranged in position in the mouth of the patient.

In fig. 4, a further embodiment of the invention, the beam blank is pre-formed to include a voluminous part 9 (a part with an extended cross-section), intended for final machining to a replacement tooth 10 directly by the numerically-controlled machining tool. In this way, the step of building up the shape of the tooth by means of ceramics or similar around a core or direct from a straight beam is avoided.

It is similarly possible in a further embodiment to use a larger-sized blank to produce caps 11 with the shape of the tooth they are intended to replace and thereby execute a solid crown made in one piece.

The cap can as such, and according to individual wishes, be given an outer shape in the whole range from it just exceeding the prepared tooth to it forming a crown that completely reproduces a tooth.

In the latter embodiment, the cut-out cavity for the end piece of the beam is executed as a cut-out groove 6 in the area on the side of the crown. The groove is executed with an inlet opening 6b that, following the assembly of the end piece of the beam, is sealed with a complementary formed plug 12 in ceramic material, plastic or preferably the same ceramic material in which the crown is made. The plug, which is partly intended to fill the groove and partly to fill out the crown adjacent to the groove, can be fixed in place by a suitable manner, e.g. by means such as glue, cement, etc.

The blank for producing a cap or a crown preferably has a pre-formed cavity on its underside where the machining to a shape complementary in relation to the individual prepared tooth for which the cap or crown is intended takes place. Furthermore, the blank for producing a cap or a crown preferably has a pre-formed cut-out cavity or groove for accommodating the end piece of the beam. These pre-formed cavities avoid difficulties of making holes or cavities in the surface of the material, which is time-consuming, causes a high degree of wear on the tool and risks forming cracks. Only the final machining, which requires a lesser volume of material to be cut-away, remains in such parts.

With knowledge of the position and shape of the cut-out cavity of the blank of the cap, which is known when the cap is designed and the blank from which the cap is to be produced is chosen, the beam and its end piece can be completed. The exact position and shape of the end piece can be determined by the computer and the machining instructions transferred to the machine tool that completes the machining of the chosen blank. If it is wished that the beam should even include whole replacement teeth, a blank available in suitable numbers and sizes is chosen. The machine tool produces the beam from the blank and the bridge can be assembled. The building up of the restoration component thus takes place in the computer program. Caps, cores, plugs, tooth shapes, connections, etc. are built-up and adjusted to one another and to the blank available.

The plug for the groove is preferably made from a pre-formed blank and given its final shape when the shapes of the crown and the end piece of the beam have been fixed. The shape of the plug is calculated by the computer using knowledge of the geometry of the adjacent components.

For increased precision, information about the topography of the plane of the teeth opposite can additionally be supplied as a limiting factor when designing the shape of the replacement teeth.

A detailed description has been given of an embodiment of the invention where the focus is on the restoration of a damaged row of teeth with two foundations and two teeth missing between them. It is nevertheless obvious for the person skilled in the art that the system is equally applicable to restoration needs where, for example, a different number of teeth are missing or in situations where there is only one foundation and teeth, a tooth, or a part of a tooth are missing on one or both sides of this foundation. Even continuous components that, for example, recreate

the row of teeth from the whole lower jaw can be achieved when this is firmly attached at a greater or lesser number of foundations.

Claims

1. Dental restoration component including a cap (2; 11) for attaching firmly to a ground-down tooth (1) or other foundation and at least one beam (3) extending out from this, whereby the cap and the beam are executed in ceramic material c h a r a c t e r i s e d in that the cap (2) has a cut-out cavity (6) to interact with an end piece (7) arranged on the beam, that the cavity (6) has partly an inlet opening (6b) that allows the insertion of the end piece in the cavity and partly an opening (6a) against the beam, that the end piece (7) is shaped to complement the cavity so that it fits exactly in the cavity (6), whereby a comparatively stable and durable attachment between the beam and cap is achieved, that adhesive material is arranged in the inlet opening to prevent the end piece being dislodged from the cavity in a vertical direction, whereby all parts are essentially lying in direct contact with one another and transferring forces between one another and that their mutual positions respective to one another are fixed and regulated by the shape of the surfaces of the joined parts.

2. Dental restoration component according to claim 1 c h a r a c t e r i s e d in that the beam (3) has an expanded cross-section (5) in at least one specified position that constitutes the position of a replacement tooth.

3. Dental restoration component according to any of the previous claims c h a r a c t e r i s e d in that the cap has a shelf-shaped projection (6´) including a cavity (6) for accommodating the end piece of the beam (7).

4. Dental restoration component according to any of the previous claims c h a r a c t e r i s e d in that the outer shape of the cap resembles a tooth (11) and that a plug is arranged in the cavity along the beam, whereby the plug fixes the end piece in position and provides the cap with a tooth-like shape around the cavity.

5. Procedure for producing a dental restoration component according to claim 1 c h a r a c t e r i s e d in that geometric information about the prepared restoration site is read into a computer, that the restoration component is designed and divided in a computer program into, e.g. caps and beams, that suitable blanks, e.g. cap blanks and beam blanks, are selected from a specified number of roughly pre-formed blanks, that a numerically-controlled machine tool executes the machining of the respective blanks to, e.g. a cap and a beam, that the parts are assembled and fixed for building the finished restoration component before the restoration component is fitted to the patient.

6. Procedure according to claim 5 c h a r a c t e r i s e d in that the restoration component is coated with ceramic or plastic to recreate a tooth or row of teeth.

7. Procedure according to claim 5 c h a r a c t e r i s e d in that the cap blank is machined so that the shape reproduces a tooth having a cut-out cavity (6), that a plug is machined to fit the cavity (6) and provide the cap with the shape of a tooth at the cavity.

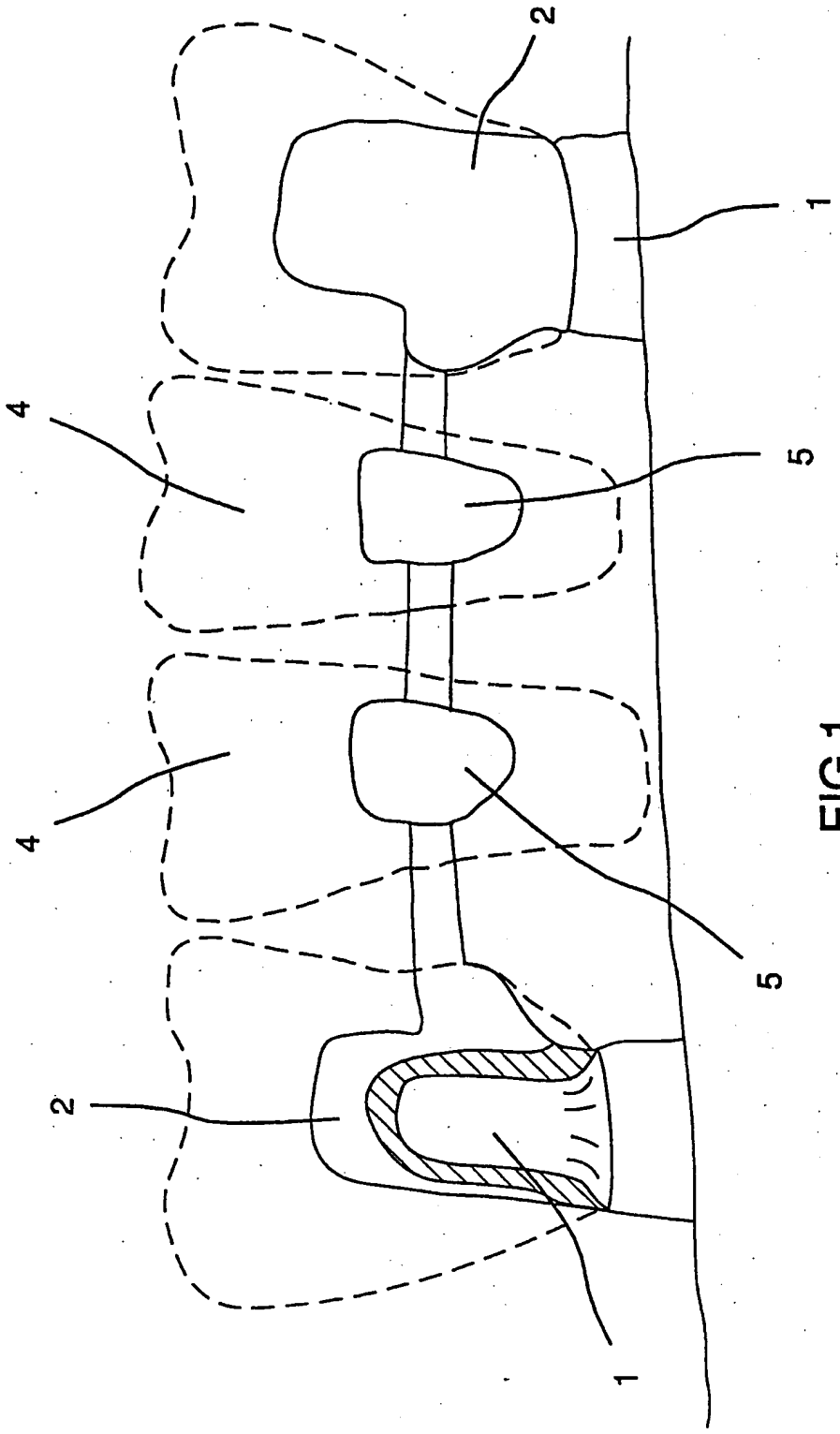

FIG.1

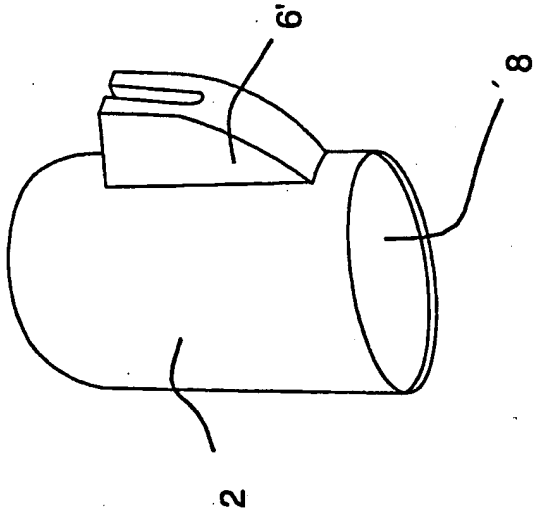

FIG.3

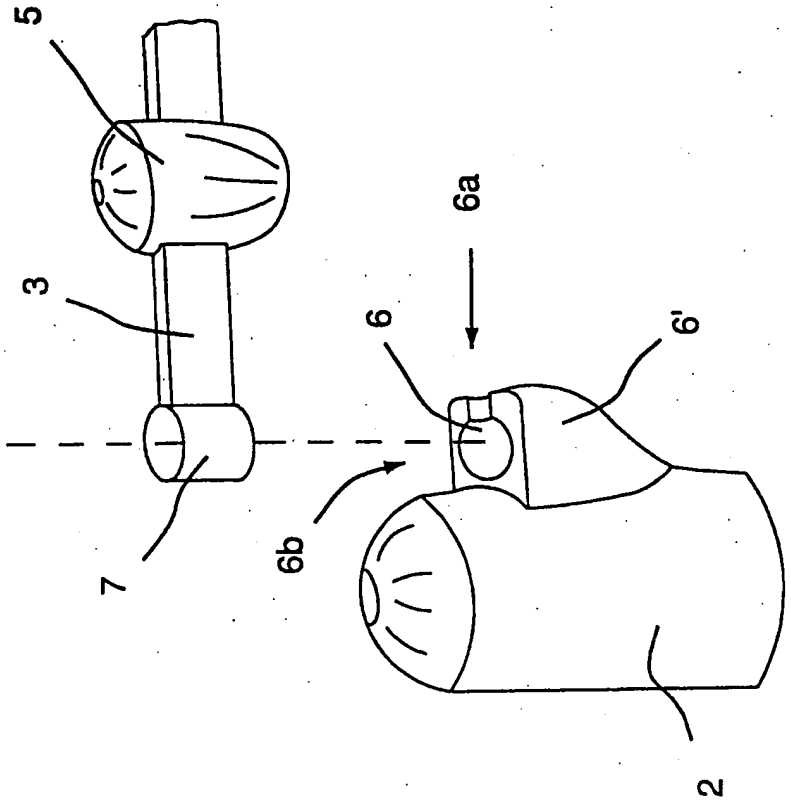

FIG.2

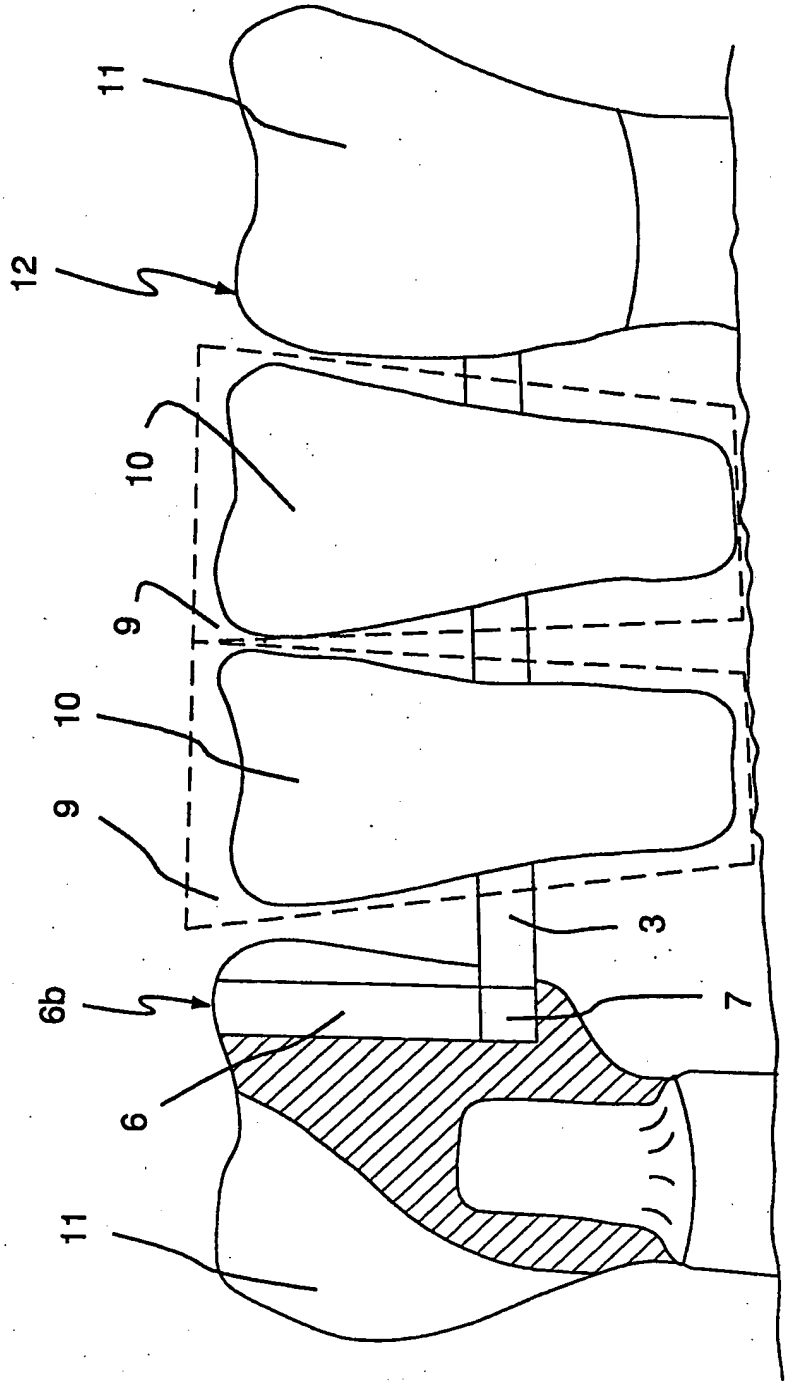

FIG.4

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61C 13/225
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0200835 A1 (CORNING GLASS WORKS), 12 November 1986 (12.11.86) --	1-7
A	US 4711631 A (PETER K. THOMSEN), 8 December 1987 (08.12.87) --	1-7

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Information on patent family members

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EP 0200835 A1	12/11/86	SE 0200835 T3	
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